

Request for Information

General Information

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1. Background

The NASA Aeronautics Research Mission Directorate has recently restructured its Aeronautics Research into three separate programs: *Fundamental Aeronautics*, *Aviation Safety*, and *Airspace Systems*. The specific purpose of this Request for Information (RFI) is to solicit external interest in collaborative public-private research partnerships under NASA's Aviation Safety Program:

Aviation Safety Program: This program will build upon the unique safety-related research capabilities of NASA to improve aircraft safety for current and future civilian and military aircraft, and to overcome aircraft safety technological barriers that would otherwise constrain the full realization of the Next Generation Air Transportation System. This program will also provide long-term investment in research to support and sustain expert competency in critical core areas of aviation and aircraft safety.

While not part of this RFI, separate RFIs will also be issued for NASA's other two Aeronautics Research programs:

Airspace Systems Program: The top-level goal of this program is the development of high capacity, efficient, and safe airspace and airportal systems that will enable the Next Generation Air Transportation System, as defined by the Joint Planning and Development Office.

Fundamental Aeronautics Program: The top-level goal of this program is the development of system-level, multi-disciplinary capabilities for both the civilian and military applications. This program provides long-term investment in research to support and sustain expert competency in critical core areas of aeronautics technology.

2. Description

Under this RFI, NASA solicits interest from primarily industry in entering into collaborative research in Aviation Safety that benefits both NASA and industry. NASA intends to use its authority under the National Aeronautics and Space Act of 1958, as amended ("Space Act"), to enter into non-reimbursable agreements where each party funds their own participation in the research effort. One or more initial agreements are anticipated. Responses from individual or industry teams, including existing or proposed consortia, are sought. Of particular interest are industry consortia to enhance NASA's research portfolio that will lead to revolutionary system-level capabilities. While educational institutions may also respond to this RFI, it is anticipated that a NASA Research Announcement (NRA) soliciting participation by educational institutions, non-profit organizations, and companies engaged in foundational research will be issued in early 2006.

This RFI seeks potential sources that have an interest in non-reimbursable collaborative R&D activities that address current, emerging, and future aircraft safety technical challenges facing both military and civil operators. The four (4) thrust areas established for the Aviation Safety Program are Integrated Vehicle Health Management, Integrated Resilient Aircraft Control, Aircraft Aging and Durability, and Integrated Intelligent Flight Deck Technologies. See Appendix A for additional detail on the Aviation Safety Program and each thrust area.

NASA intends to provide long-term support in the thrust areas above and focus its resources on fundamental aircraft safety research and technology development that enables multidisciplinary and system-level capabilities. The anticipated outcome from these investments is an expanded knowledge base to overcome aircraft safety technological barriers that would otherwise constrain the realization of future capabilities of the Next Generation Air Transportation System. As NASA does not typically build or operate military or commercial aircraft, we look toward partnerships with industry to help us identify emerging safety concerns and advance the technologies to continually improve aircraft safety.

Consistent with the Space Act, a key element of the restructured Aeronautics program is that the Nation's aeronautical expertise and unique facilities are maintained as national assets for the benefit of both the civilian and military aeronautics communities.

3. Process

NASA Headquarters oversees the Aeronautics Research Programs and implementation occurs principally at four NASA field centers (Ames Research Center, Dryden Flight Research Center, Glenn Research Center, and Langley Research Center). In Fiscal Year 2006 a four-step process will be used to define the Aeronautics Research Programs:

- Step 1: Assess the long-term research needs and goals in the Aviation Safety Program and establish technical roadmaps to accomplish those goals. In developing those roadmaps, prioritize according to NASA's unique strengths and capabilities. Establish multi-center, multidisciplinary teams across the areas of Integrated Vehicle Health Management, Aircraft Aging and Durability, Integrated Resilient Aircraft Control, and Integrated Intelligent Flight Deck Technologies. These roadmaps will be discussed further at the 44th American Institute of Aeronautics and Astronautics (AIAA) Aerospace Sciences Meeting and Exhibit, January 9-12, 2006 in Reno, Nevada.
- Step 2: Solicit information through this RFI on the key areas of interest from the external community and determine potential areas to form collaborative arrangements.
- Step 3: Develop research proposals at the field centers in each of the four thrust areas and establish NASA research teams. The responses to this RFI will provide important source material to the NASA research teams to be used in establishing specific collaborative partnerships as part of their proposals to NASA Headquarters.
- Step 4: NASA intends to issue NASA Research Announcements (NRA, see NASA Federal Acquisition Regulation Supplement Part 35) to solicit proposals for foundational research in areas where NASA needs to enhance its core capabilities. Foundational research is defined as research that furthers our fundamental understanding of the underlying principles associated with complex safety-related problems. NASA anticipates that educational institutions, non-profit organizations and industry engaged in foundational research will be the primary recipients of awards under the NRA.

4. Information for Respondents

4.1 How to Respond

NASA anticipates providing additional information about its Aeronautics Research Programs on or about January 12, 2006, at the AIAA conference in Reno, Nevada. NASA also anticipates providing this additional information on the following website: www.aeronautics.nasa.gov.

The website above will be used to post information about, or modifications to, this RFI. Prospective respondents are urged to periodically check this web site for updates.

Respondents are requested to provide a description of a proposed non-reimbursable collaboration with NASA. Responses shall describe: (1) the respondent's team and expertise, key personnel and capabilities, and the R&D collaboration approach and areas of interest; (2) respondent's facilities and resources (including test data) to be provided as part of the collaboration; and (3) what is expected or requested of NASA as part of collaboration (including Government facilities or other resources). Partnerships will be limited to US companies.

Responses must be a maximum of five (5) pages, with minimum 12-point Times font. All proposals shall include the company name, point-of-contact, address, and phone number. All proposals shall clearly indicate which one of the four thrust areas in the Aviation Safety Program is addressed in the proposed partnership, by affixing the name of the program thrust (either "Aircraft Aging and Durability", "Integrated Intelligent Flight Deck Technologies", "Integrated Vehicle Health Management", or "Integrated Resilient Aircraft Control") in the upper right hand corner of each page in your proposal. All proposals shall include an e-mail address for the point-of-contact in order to expedite communications.

Please submit all responses in electronic format to the Point-of-Contact listed below by **NOON Eastern Standard Time, January 31, 2006**:

Name: Mr. John White
Title: Deputy Director, Aviation Safety Program
Phone: 202-358-5157
Email: rfi_avsp@nasa.gov

Questions regarding this RFI should also be addressed to the above Point-of-Contact.

4.2 Evaluation Factors

The evaluation process NASA intends to use for selecting collaborative partnerships (under non-reimbursable Space Act Agreement[s]) has been designed for this RFI. Respondents are reminded that this process does not involve the

procedures set forth in the Federal Acquisition Regulation (FAR) nor the NASA FAR supplement since this announcement will not result in the award of a contract, grant, or cooperative agreement.

Responses will be assessed on the following evaluation factors:

- Overall responsiveness to furthering the goals of this RFI, in particular the objectives and results-oriented goals of NASA's Aviation Safety Program
- Technical Confidence in the research proposed under the collaborative activity
- Management Confidence in the structure and management of the proposed collaborative activity

The NASA Point-of-Contact referenced in Section 4.1 will provide the RFI responses to the NASA planning lead of the thrust area identified by the respondent. Based upon assessment of the responses, as part of the process of submitting proposals under Step 3 (see "Process" above), the planning leads may contact RFI respondents to finalize terms and conditions of agreements.

4.3 General Information

4.3.1 Proprietary or Confidential Information

Respondents are NOT to provide any information that is considered proprietary, trade secrets, or privileged or confidential.

4.3.2 Intellectual Property

Intellectual property rights between NASA and collaboration partners can be negotiated to fit the goals of the parties. Under NASA's standard approach, title to inventions remain with the respective inventing parties without any exchange of rights unless otherwise agreed. Proprietary data developed and provided by the collaboration partner to NASA remains proprietary. NASA takes no rights in background inventions or data developed prior to or outside of collaborative agreements under this RFI.

NASA requires that consortia and teams agree to intellectual property rights among members prior to finalizing terms and conditions of a non-reimbursable Space Act Agreement.

Respondents to this RFI may comment on this general approach and/or suggest alternate approaches to intellectual property rights between NASA and the partner.

4.3.3 Compliance with U.S. Laws, Regulations, and Policies

Proposals must comply with all applicable U.S. laws, regulations and policies.

4.3.4 Use of Government Resources

In support of this RFI, the Government will consider requests from respondents for Government furnished resources and technologies. Requests for use of Government equipment, facilities or services should be provided to the Point-of-Contact for this RFI.

4.3.5 Period of Performance

The Government anticipates that proposed research collaborations under Space Act Agreements will have an initial period of performance of five (5) years, unless otherwise agreed to by the parties

4.3.6 RFI Issuance and Response Selection

NASA will not issue paper copies of this RFI. NASA reserves the right to select for negotiations all, some, or none of the proposed collaborative partnerships in response to this RFI.

APPENDIX A: Information on AVIATION SAFETY

NASA has defined a four-level approach to technology development in each of the four Aviation Safety thrust areas: (1) conduct foundational research to enable a detailed understanding of the underlying principles associated with the complex safety-related problems being addressed and to enable disciplinary advances to address those problems; (2) leverage the foundational research to develop methods, tools and technology components that enable the development and validation of technology solutions; (3) develop integrated methods, tools, and technology subsystems that enable the development and validation of multidisciplinary technology solutions to address multiple safety hazards and their coupled effects; and (4) develop and validate technology solutions that utilize system-level multidisciplinary optimization, assessment, and integration methods to address a broad range of safety challenges and air vehicles.

The Aviation Safety Program is committed to the mastery and intellectual stewardship of aircraft safety foundational research and technology development for the Nation. NASA will focus its research in areas that are appropriate to our unique capabilities, and will partner with industry, academia, and other government agencies in complementary areas of research. NASA research is long-term and cutting-edge and is both focused and integrated across disciplines. NASA will invest broadly and deeply in core aircraft safety research at Levels 1 and 2, to produce knowledge, technology, and tools that are applicable across a broad range of air vehicles. It is anticipated that collaborative activities with industry partners will occur mainly at Levels 3 and 4 in a manner to identify and optimally address emerging safety challenges facing the Nation's Next Generation Air Transportation System.

The interaction with the aeronautics and aviation safety community at the systems level is of particular importance because NASA typically does not design and build air vehicles for operational use, and has limited operational experience that is targeted to

experimental research. We look toward collaboration with industry to provide insight into issues associated with design, manufacturing, operation and maintenance of aircraft and associated systems. NASA's role at this level is to use its expertise in relevant disciplines to develop multidisciplinary design, analysis, and optimization tools that will help resolve these issues. NASA intends to collaborate with industry consortia to provide value to industry of a more enduring nature, rather than immediate problem-solving.

Collaboration at the lower levels of research is also possible; however NASA anticipates focusing a significant portion of its core competencies and resources to these research areas and will be interested in research by others that address gaps or deficiencies in NASA research.

The following four (4) thrust areas describe the objective, anticipated results and potential NASA investment areas for Aircraft Aging and Durability, Integrated Intelligent Flight Deck Technologies, Integrated Vehicle Health Management, and Integrated Resilient Aircraft Control. Additional collaboration interests unique to each thrust area are also described.

A.1 AIRCRAFT AGING AND DURABILITY (AAD):

NASA OBJECTIVE: Perform foundational research in aging science: sensing and diagnostic technologies; physics-based modeling; computational methods; material science (metals, ceramics, composites); and characterization/validation test techniques, which will ultimately yield multi-disciplinary analysis and optimization capabilities that will enable system-level integrated methods for the detection, prediction and mitigation/management of aging-related hazards of future civilian and military aircraft.

RESULTS: Experimentally validated detection/inspection methods, predictive tools, and mitigation concepts and design guidelines for enhanced safety and durability of airframe, propulsion and flight systems.

COLLABORATION INTERESTS: In order to achieve these results, NASA seeks industry collaboration primarily on system-level capabilities in the following areas:

Detection and Characterization of Aging-Related Hazards: Establish linkage between structural analysis and NDE techniques; Damage and environmental state quantification; repair assessment.

Prediction of Life, Strength, and Durability of Aircraft Systems with Degradation: Variable fidelity analysis methods and predictive tools; methods incorporating usage and NDE information; reliability/margins of safety with uncertainty.

Mitigation of Aging-Related Hazards: Advanced material systems (surface treatment/coatings, multifunctional); degradation management; design for aging prevention, maintainability/repair, and damage containment.

Specific areas for which collaborations are sought include:

NDE systems: Once NASA research demonstrates the potential of a given technique, industry partners would develop prototypes applicable to field use.

Material data: Industry material data for emerging materials and fabrication technologies for validation of NASA efforts in material characterization.

Test articles for experiments: Industry provided relevant components (material, processing, and geometry), including used components with apparent degradation.

Test facilities: Access to test facilities for full-scale testing in relevant environment and loads.

Information and/or maintenance records: Information and/or maintenance records as a means of assessing observed aging-related issues.

Critical issues or classes of problems: Identification of critical issues or classes of problems, where NASA research may fill gaps in understanding.

Approach to technology development: Industry input on approach to technology development, bringing to bear practicality and operational issues.

A.2 INTEGRATED INTELLIGENT FLIGHT DECK TECHNOLOGIES (IIFDT):

NASA OBJECTIVE: Perform foundational research in the areas of multi-modal interface technologies; signal, speech and image processing methods; sensor technologies; detection theory; external hazard characterization; operator characterization and interaction modeling; formal design, modeling and verification methods; and information systems and infrastructure. This work will yield multi-disciplinary analysis, optimization, and predictive capabilities that will enable system-level designs of revolutionary adaptive flight decks that improve safety for a range of missions, vehicle classes, and crew configurations.

RESULTS: Validated physics-based multi-disciplinary tools, methods, concepts, principles and technologies for revolutionary adaptive flight decks that enable future generation aircraft to fly any mission with improved safety.

COLLABORATION INTERESTS: In order to achieve these results, NASA seeks industry collaboration primarily on system-level capabilities in the following areas:

Tailored Flexible Operator-Automation Management: Dynamic operator/automation function allocation strategies with formally verified fail-safe reversionary modes for automation assigned functions.

Adaptive Displays and Interaction: Equivalent visual environments; spatially-integrated displays that enable optimal presentation and management of flight deck information; optimized controls and displays that support extra- and intra-flight deck information coordination.

Decision Associate Technology: Tools and functional capabilities that support hazard remediation; situational awareness and analysis; integrated crew advisory and warnings; collaborative decision making; and tactical guidance and re-planning (collaboratively with Integrated Resilient Aircraft Control thrust area work).

Intelligent Information Management: Information systems that support the needs of technologies above while enabling integrated flight deck and external environment state assessment and safety analysis, tracking of real-time navigation, communication and surveillance performance, supporting collaborative information management (with ATC/AOC), and providing predictive information.

In addition, collaborations are sought at the sub-system level addressing monitoring technologies that detect pilot-, automation-, and/or external environment-induced hazards.

Collaboration with industry can provide NASA with a unique perspective to these issues as they are experienced with building, maintaining, and operating current flight deck systems and are cognizant of the limitations and gaps of the current technology. Recent collaborations with industry have been very successful and NASA hopes to continue this tradition. These collaborations can fill a critical need with respect to future flight deck concepts, their practicality, and their validation. Additionally, sharing access to test facilities, aircraft, and equipment for testing in relevant environments is of interest to NASA. For all collaborations, temporary exchanges of personnel and the sharing of test facilities, aircraft, and equipment for testing in relevant environments are also of interest to NASA.

A.3 INTEGRATED VEHICLE HEALTH MANAGEMENT (IVHM):

NASA OBJECTIVE: Perform foundational research in physics based and data driven failure modeling; advanced data analysis and data mining; sensor and actuator technology; state awareness; advanced material for IVHM; detection theory and reasoning methods; IVHM architectures, design methods, and analytical, simulation, and experimental methods for IVHM technology verification and validation, which will ultimately yield integrated multi-disciplinary analysis and optimization capabilities that will enable system-level design of a wide class of aircraft that will provide graceful recovery from in-flight failures, computationally efficient tools for in-flight prognosis of aircraft health including integrated predictive and sensor capabilities, and preventative and adaptive systems for in-flight operability and informed logistics and maintenance.

RESULTS: Validated multi-disciplinary tools and technologies that enable the design, integration and validation of vehicle-wide IVHM systems.

COLLABORATION INTERESTS: In order to achieve these results, NASA seeks industry collaboration primarily on system-level capabilities in the following areas:

Airframe Health Management: Self-awareness and prognosis; anomaly detection and identification; in-flight damage, degradation and failure mitigation.

Propulsion Health Management: Self-awareness and prognosis of gas path, combustion, and overall engine state; fault-tolerant system architecture.

Aircraft systems Health Management: State-awareness and prognosis of landing gear, hydraulic and pneumatic systems, electrical and power systems, fuel and lubrication systems, and avionics/communication-navigation-surveillance/flight critical/flight management systems; robust distributed fault-tolerant self-recoverable architectures.

Environment Health Management: Prevent, detect, and mitigate the effects of hazards such as onboard fire and fuel detonation; interior air quality degradation; ice; lightning strikes; EMI/EMC; and ionizing radiation.

IVHM System Architectural Framework: System design, analysis and optimization; information management, data flow and communication; control and reconfiguration; architecture development and validation.

Validation and Predictive Capability Assessment: Analysis, simulation, ground-testing, flight testing, environmental testing, and software assurance.

Recent collaborations with the aviation industry and air fleet operators related to Aviation Safety have been very successful, and NASA hopes to continue this tradition.

Collaborations with aircraft manufacturers, original equipment manufacturers, and other companies in the aviation industry are sought to provide a unique perspective to technology development in IVHM, since they are experienced in building the current state-of-practice in IVHM systems design and development, are cognizant of the current IVHM technical limitations and gaps, and fill a critical need with respect to future IVHM concepts and their practicality. Collaborations with air fleet operators are sought for IVHM research to provide a unique perspective on fleet maintenance operations and future needs in cost-effective and efficient IVHM.

A.4 INTEGRATED RESILIENT AIRCRAFT CONTROL (IRAC):

NASA OBJECTIVE: Perform foundational research in vehicle dynamics and hazards effects modeling and simulation methods for coupled hazard effects assessment; detection, identification and prediction methods for flight safety diagnostics and prognostics; control and guidance methods for hazard mitigation, control recovery, and vehicle autonomy under adverse and emergency conditions; robust design and risk analysis and mitigation methods; advanced control structures and materials for resilient control; instrumentation for intelligent sensing, monitoring, and control; validation methods for complex models and adaptive systems; and software safety assurance and formal verification methods for safety-critical systems, leading to multi-disciplinary analysis and optimization capabilities that enable the development and validation of system-level integrated resilient control technologies to provide graceful recovery from potentially catastrophic in-flight failures/damage, external disturbances, vehicle upsets, and system and control input errors; as well as effective vehicle-based flight/mission management under adverse, upset, and hazards conditions.

RESULTS: Validated physics-based multidisciplinary integrated modeling, control and validation and verification (V&V) technologies that enable hazard-resilient aircraft control and flight management.

COLLABORATION INTERESTS: In order to achieve these results, NASA seeks industry collaboration primarily on system-level capabilities in the following areas:

Resilient Flight Control: Fault tolerance and hazard effects protection; onboard hazard effects assessment, mitigation and recovery.

Resilient Propulsion Control: Damage tolerance and design for extended envelop operation; onboard hazard effects assessment, mitigation and recovery.

Resilient Airframe Control: Damage tolerance and structural damage avoidance; onboard damage effects assessment, mitigation and recovery.

Resilient Vehicle Mission Management: Control and performance management; vehicle-based mission management and autonomous collision avoidance; interface and communication management.

Safety-Critical System V&V: Safety assurance methods for complex avionics systems; integrated V&V methods, tools and test techniques for adaptive control systems; predictive capability assessment methods and tools.

Recent collaborations with aviation industry and air fleet operators related to Aviation Safety have been very successful, and NASA hopes to continue this tradition. Collaborations with airframe, engine, and avionics manufacturers and other companies in the aviation industry are sought to provide a unique perspective to technology

development in IRAC. Industrial experience in the current state-of-practice in control systems design and development as well as cognizance of the current technical limitations will serve to fill a critical need with respect to future IRAC concepts and their practicality. Collaborations with air fleet operators are sought for IRAC research to provide a unique perspective on the cost/benefit requirements of future technologies, retro-/forward-fit implementation strategies, and safety/reliability requirements.